Building ecosystem resilience through reconnecting sediment supply from creeks to tidal wetlands

Michael MacWilliams, PhD, PE

October 14, 2025

FlowWest

Outline

- Project Overview: Calabazas/San Tomas Aquino Creek-Marsh Connection project
- The role of modeling in project planning and design
- Detailed 3-D simulation of sediment transport over short time-scales
- Predicting long-term sediment accumulation and habitat evolution

Valley Water

Clean Water • Healthy Environment • Flood Protection

Project Partners

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

Coastal Conservancy

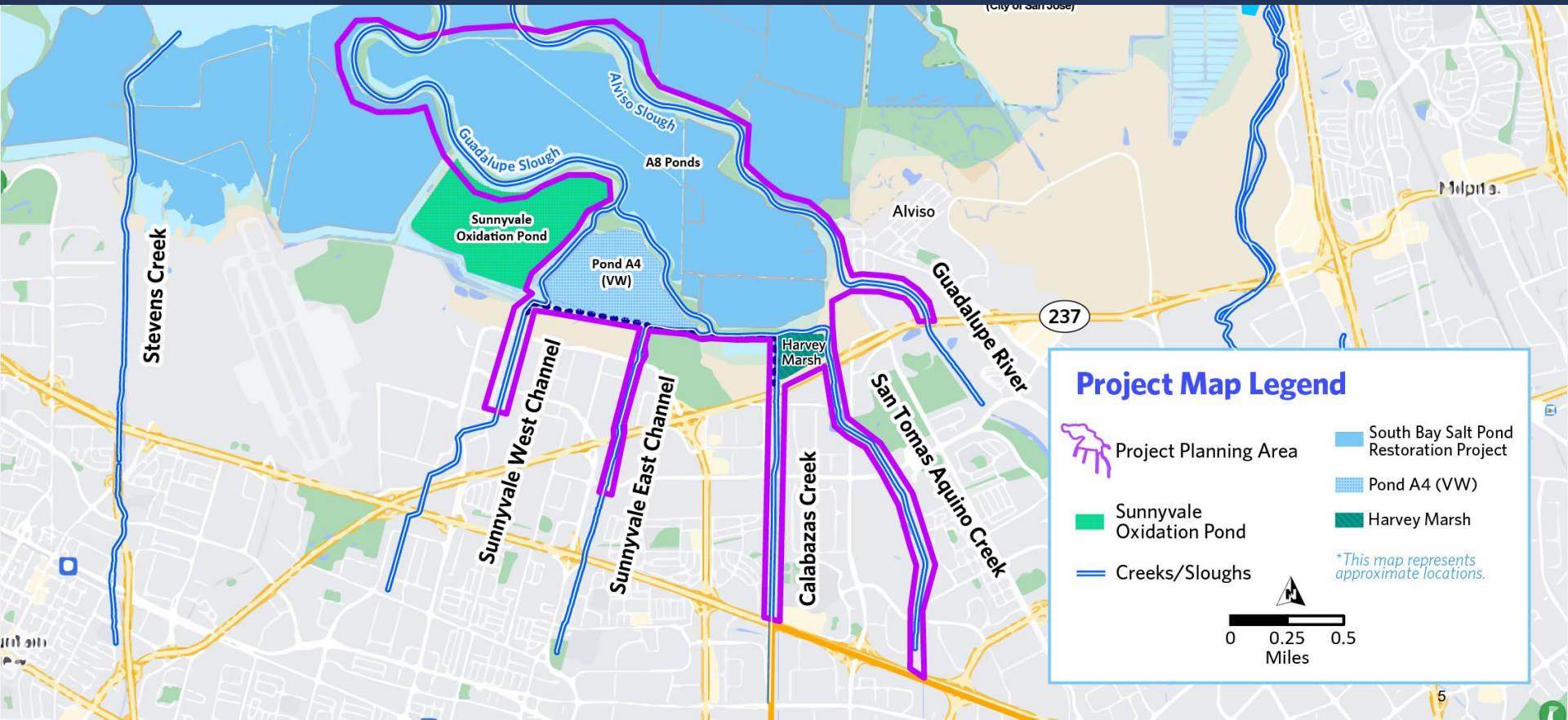
Project Funding

CALIFORNIA DEPARTMENT OF FISH & WILDLIFE

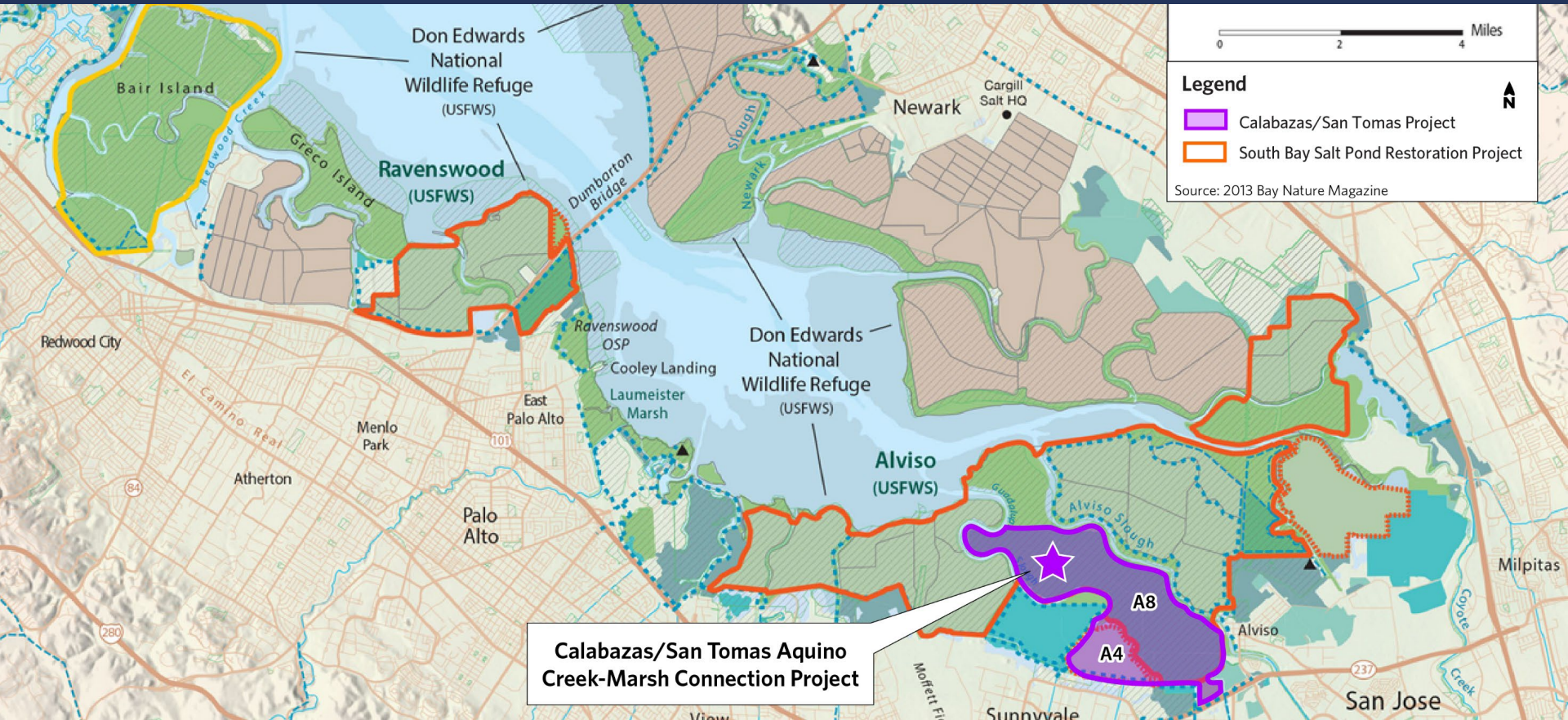
PROP 1
GOVERNOR GAVIN NEWSOM
WATER BOND 2014
RELIABILITY | RESTORATION | RESILIENCE

Project Overview

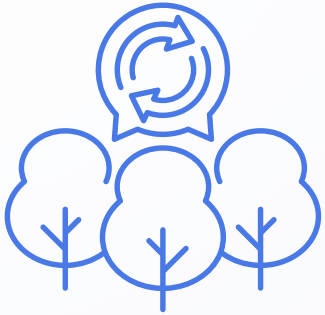
CALABAZAS/SAN TOMAS AQUINO CREEK-MARSH CONNECTION PROJECT OVERVIEW



CONNECTION TO BROADER SOUTH BAY SALT POND RESTORATION



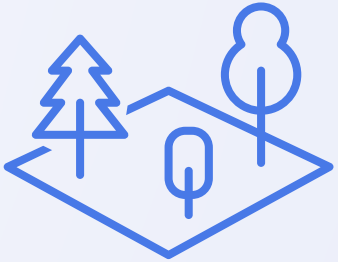
PROJECT OBJECTIVES



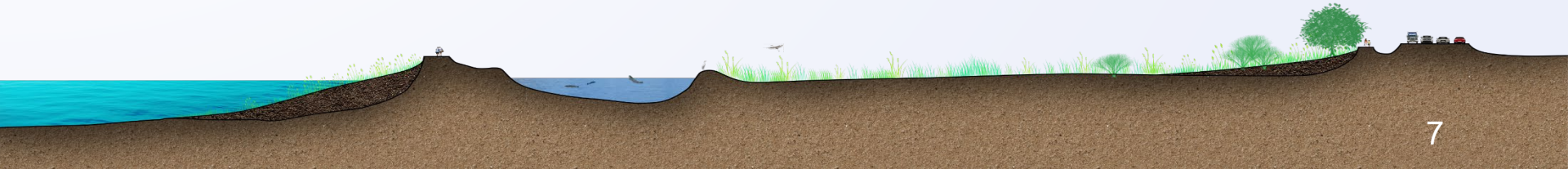
HABITAT RESTORATION

RESILIENT FLOOD PROTECTION

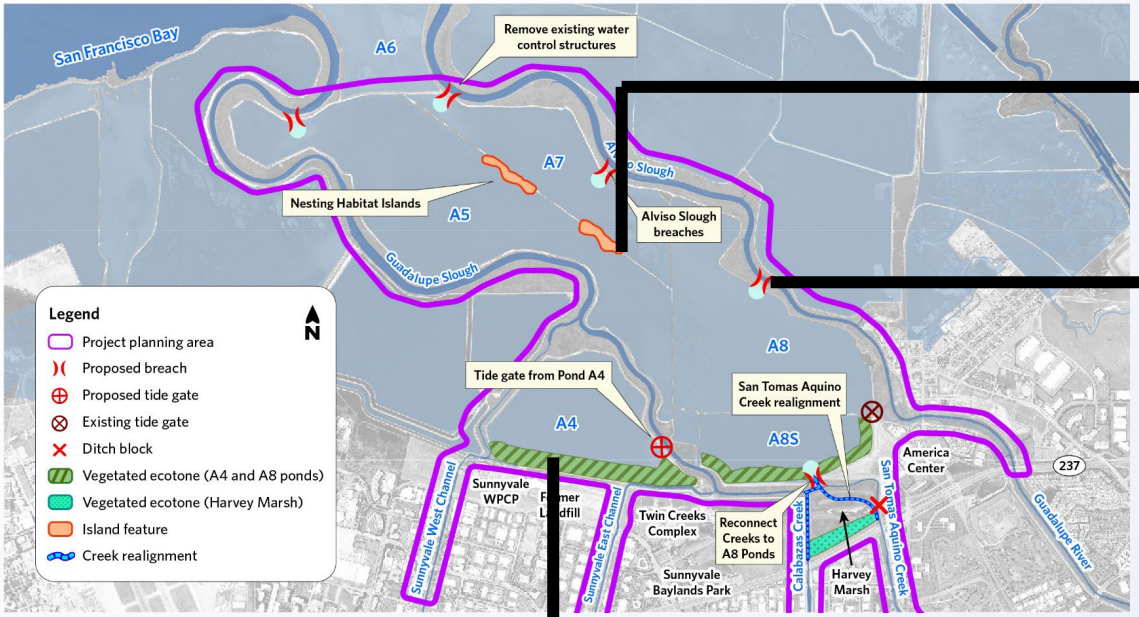
MAINTENANCE NEEDS REDUCTION

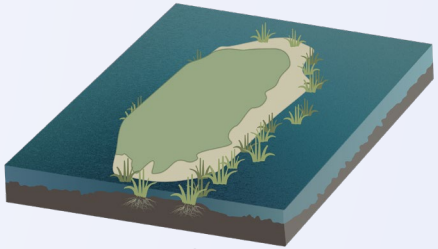


PUBLIC ACCESS ENHANCEMENT



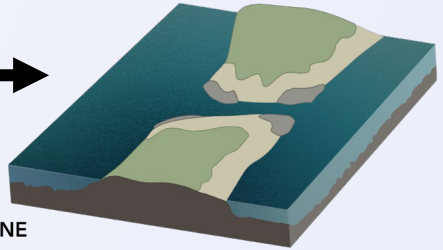
RESTORATION ELEMENTS CONSIDERED



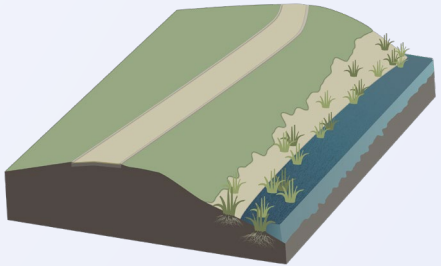


ISLAND

BREACH



ECOTONE



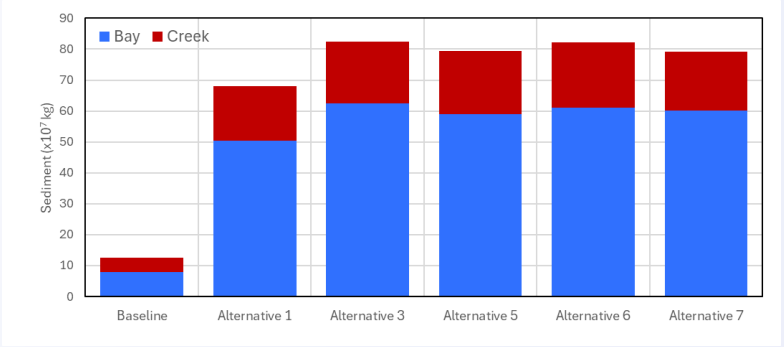
The Role of Modeling

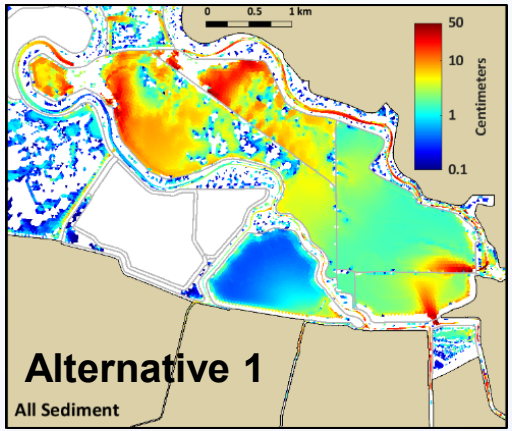
The Role of Modeling in Project Planning and Design

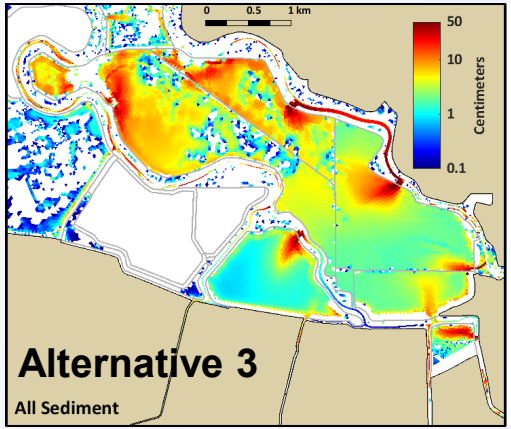
The Role of Modeling in Project Planning and Design

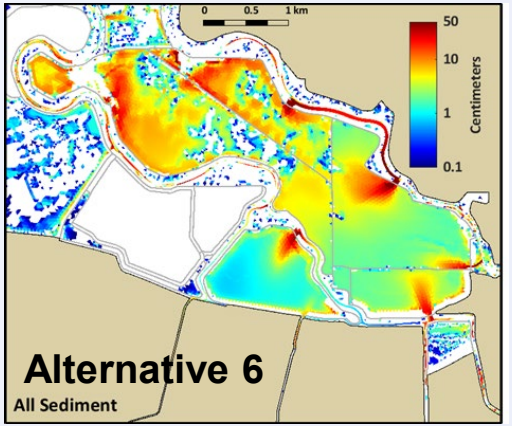
The Role of Modeling in Project Planning and Design

Models can be used to compare outcomes between alternatives





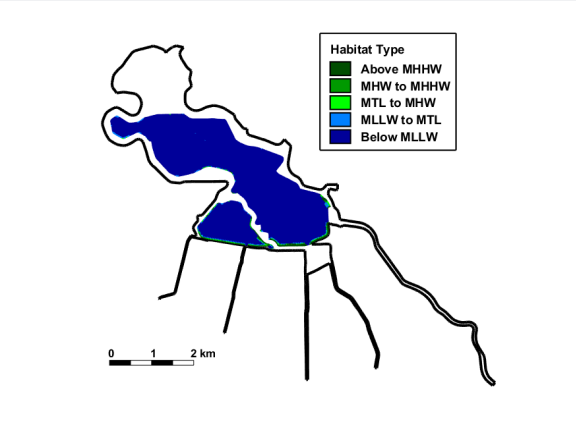




The Role of Modeling in Project Planning and Design

Models can be used to predict long-term outcomes

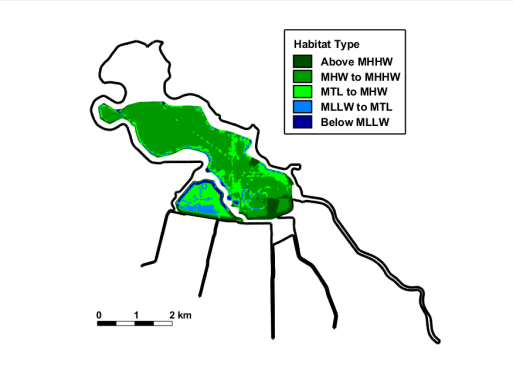
2030

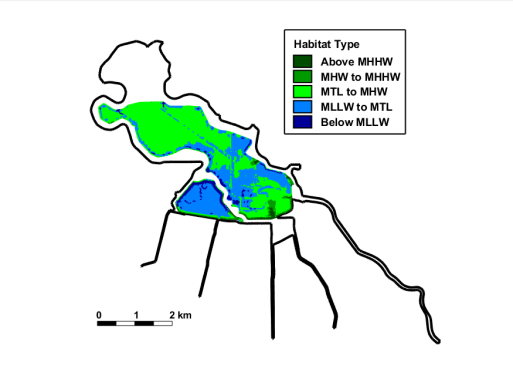


INT-LOW SLR

INT-HIGH SLR

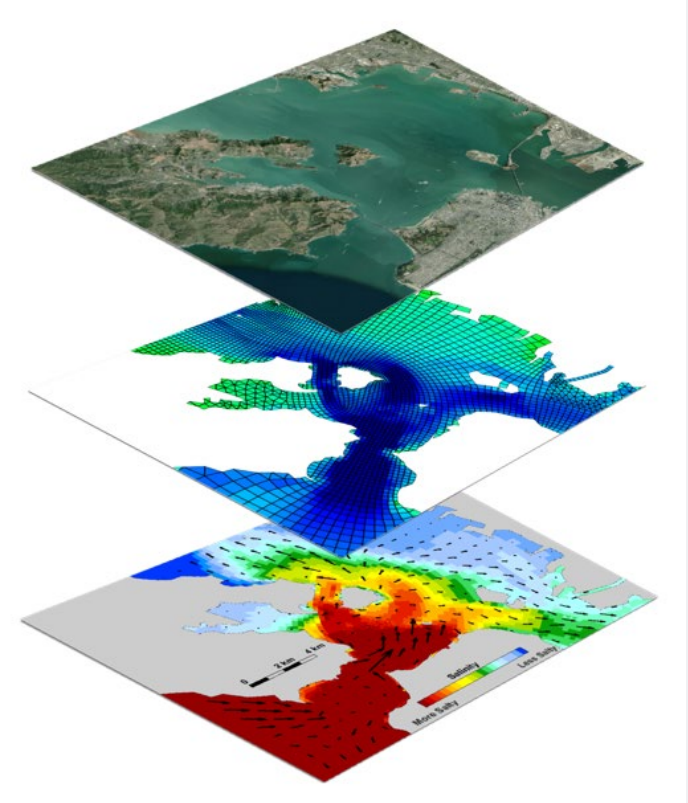
2080



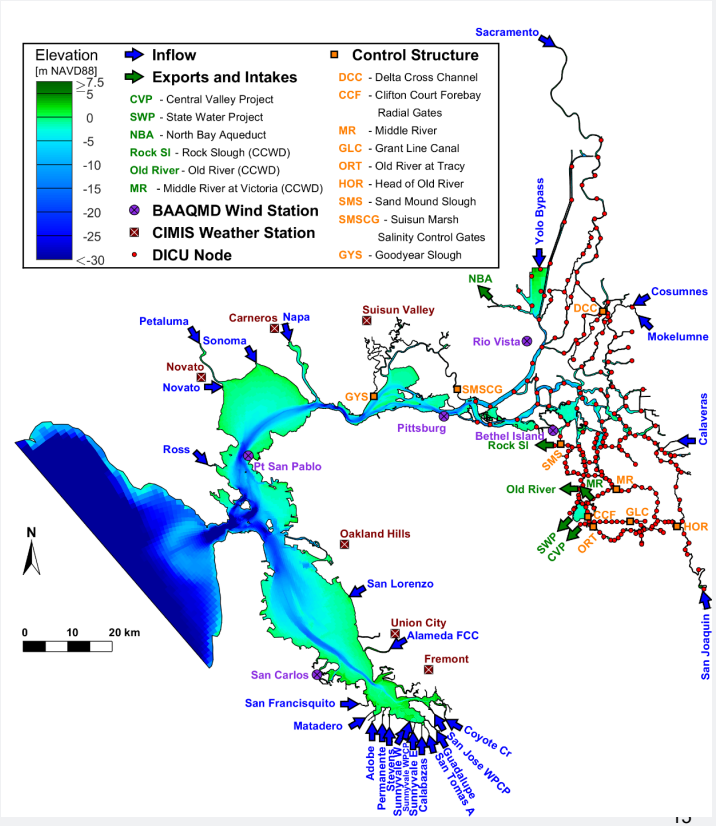


3-D Sediment Transport Modeling

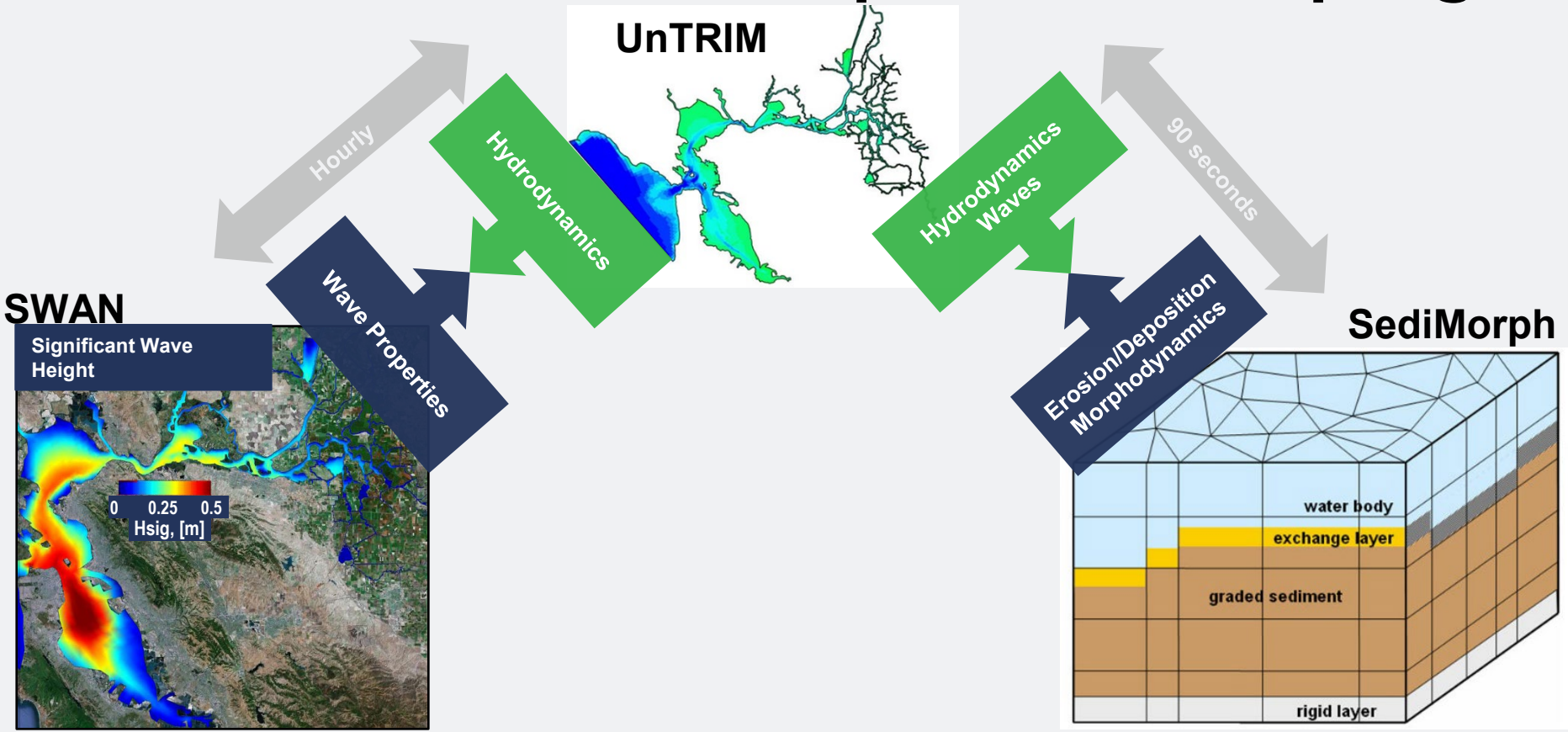
Detailed 3-D simulation of sediment transport over short time-scales



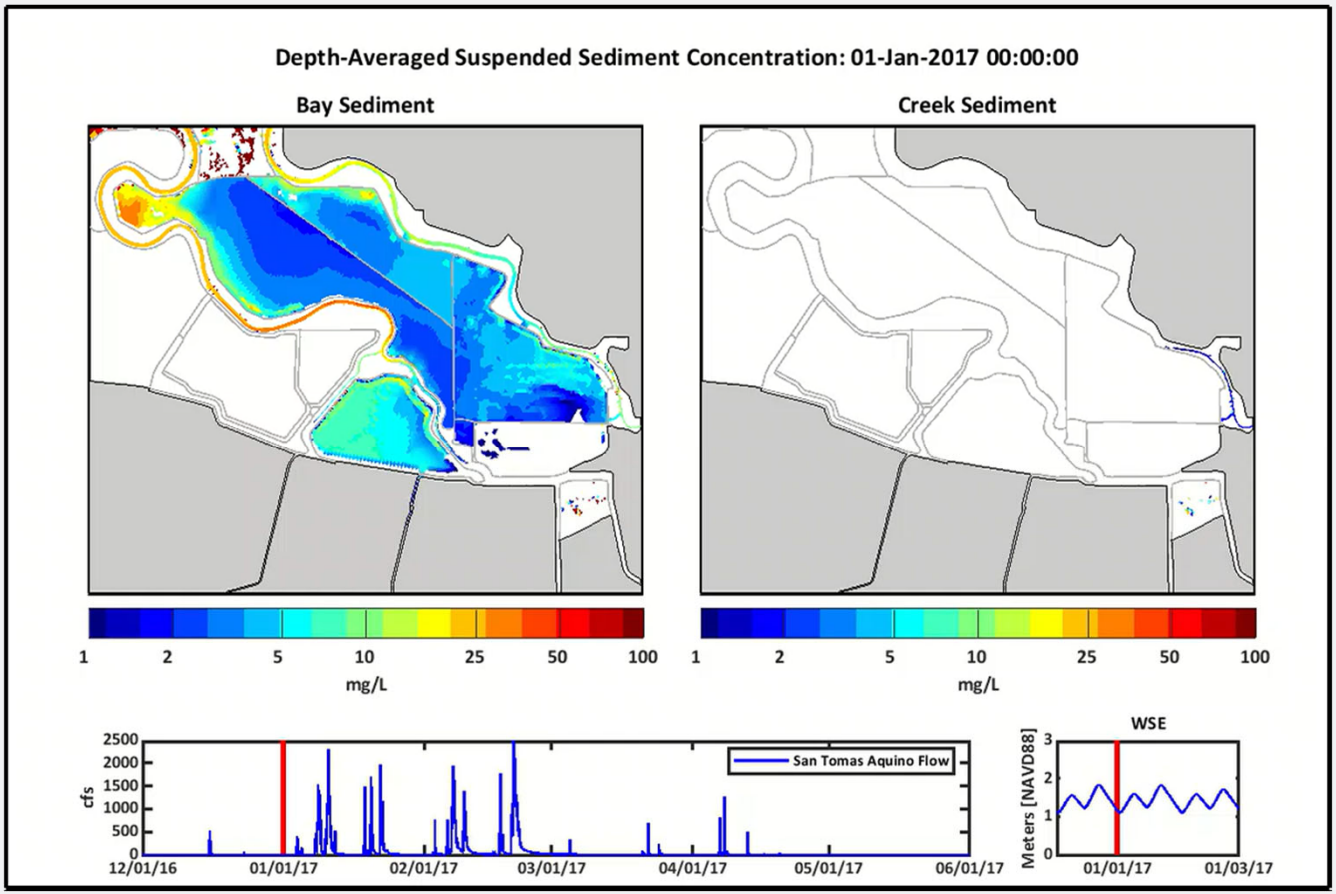
Source: MacWilliams et al. 2022



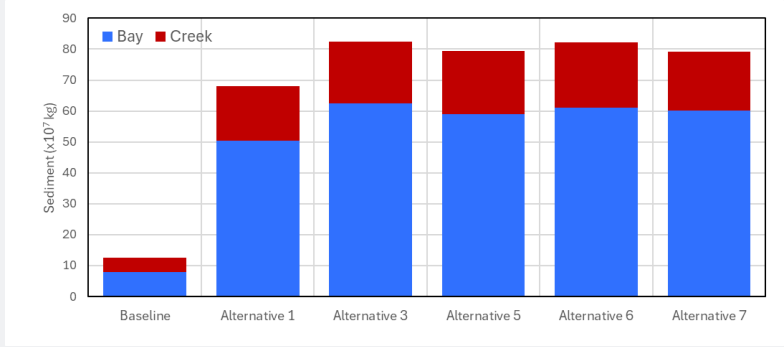
UnTRIM-SWAN-SediMorph Model Coupling

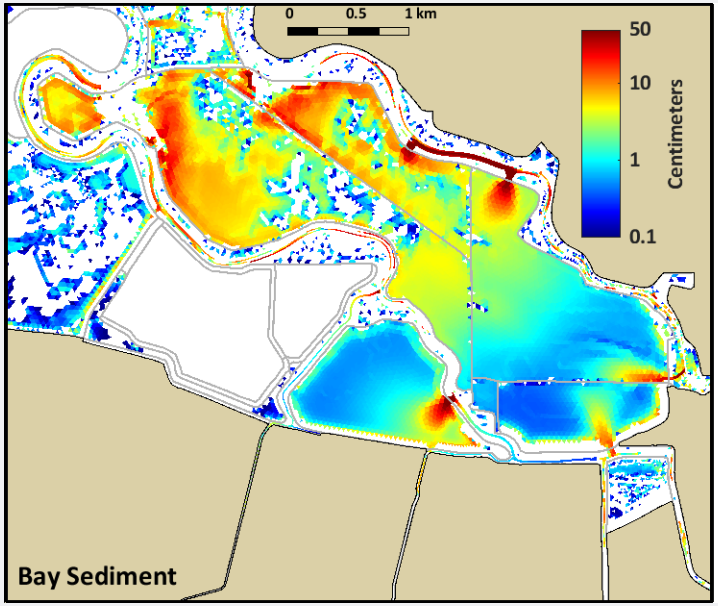


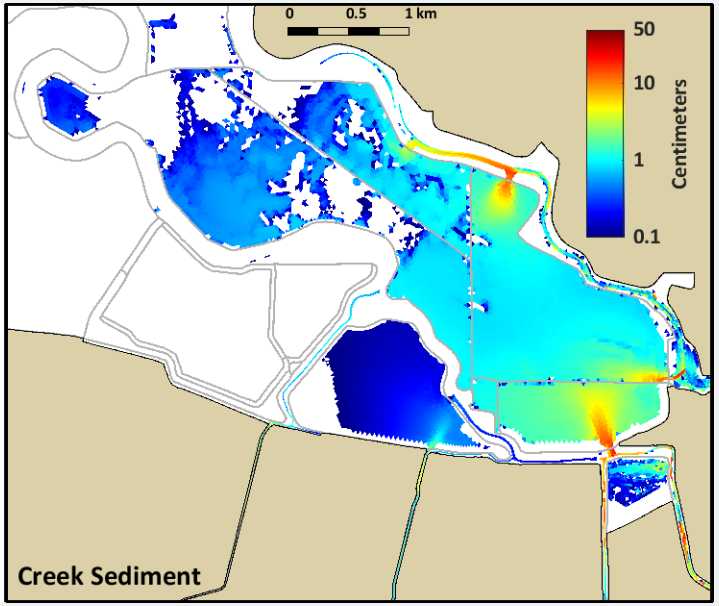
Detailed 3-D simulation of sediment transport over short time-scales



Sediment Deposition: Alternative 6

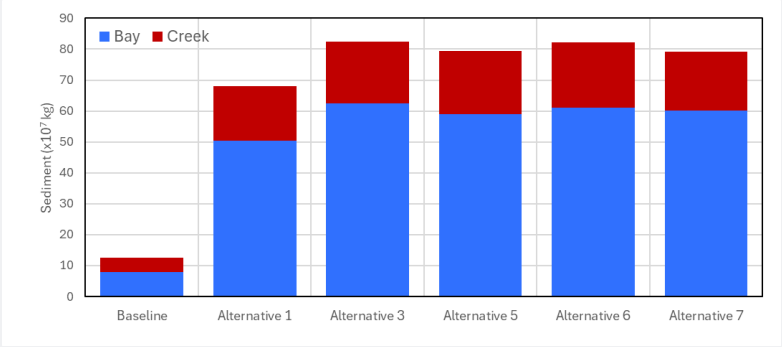


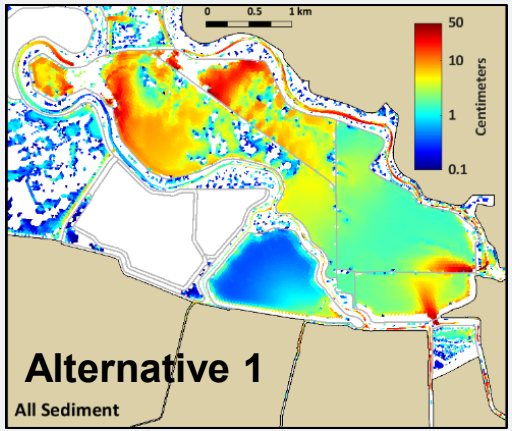


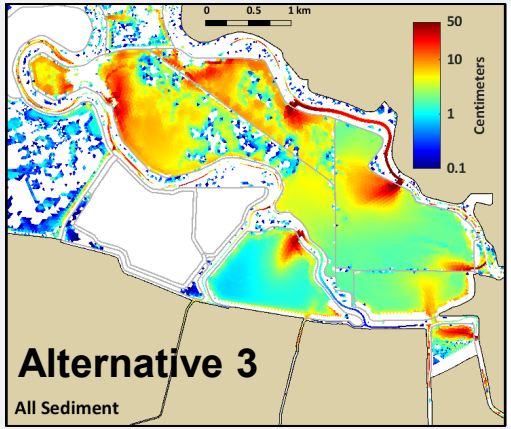


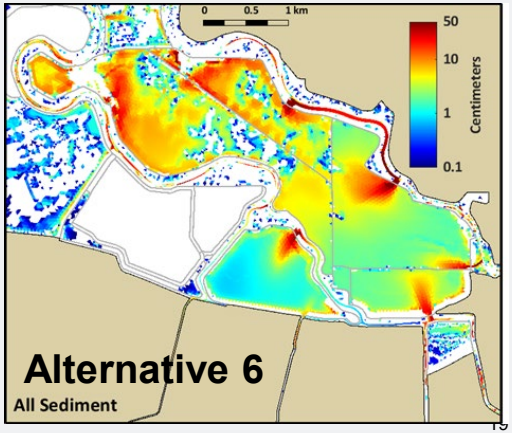
Detailed 3-D simulation of sediment transport over short time-scales

Models can be used to compare outcomes between alternatives







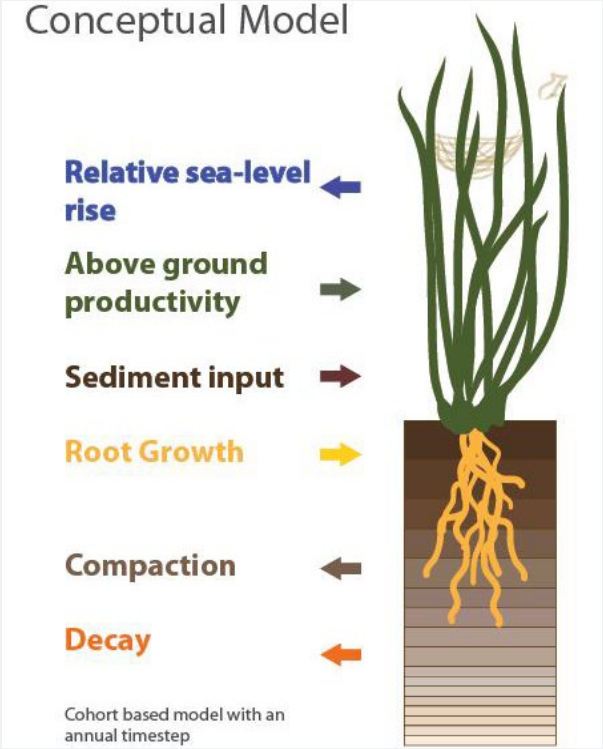


Long-Term Habitat Evolution

Predicting long-term sediment accumulation and habitat evolution

WARMER

- WARMER is a vertical 1-D model of marsh elevation that incorporates both biological and physical processes resulting in vertical marsh accretion.
- WARMER can be applied spatially based on the initial elevations in a wetland but does not account for horizontal processes

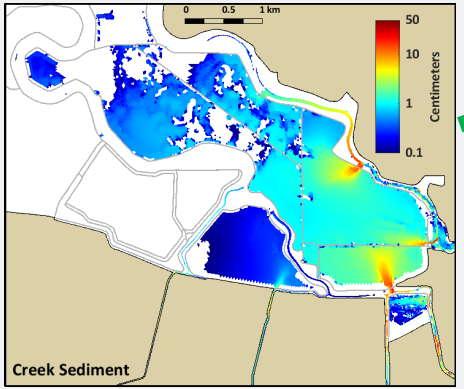


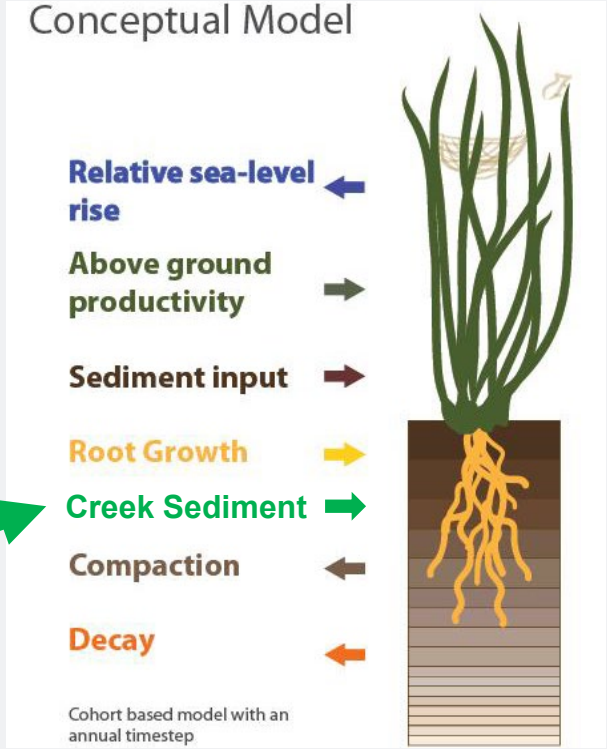
Source: Swanson et al. 2013

Predicting long-term sediment accumulation and habitat evolution

WARMER

- WARMER model was used in combination with the results of the short-term 3D sediment transport simulations to project future marsh conditions

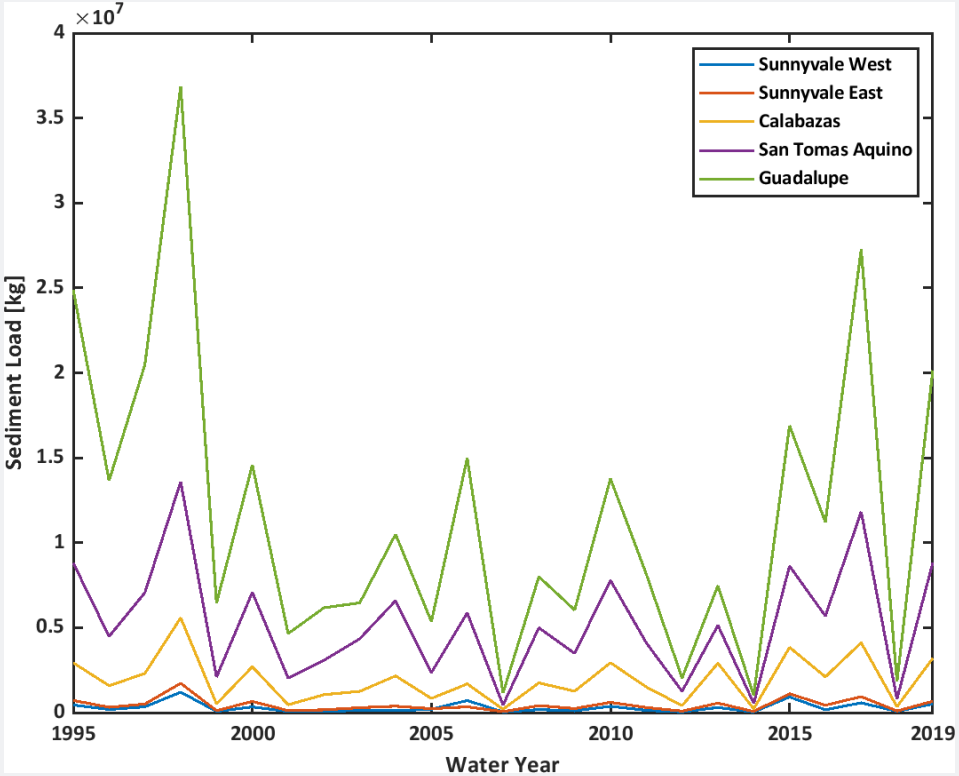




Source: Swanson et al. 2013

Predicting long-term sediment accumulation and habitat evolution

- Sediment load data from SFEI watershed model used for 25 full water years
- Sediment loading was based on WY 1995 – WY 2019 repeated twice
- Annual creek sediment load ranged from 4.21% to 131.8% of 2017 sediment load
- Creek sediment contribution to WARMER varied annually



Sea Level Rise Assumptions

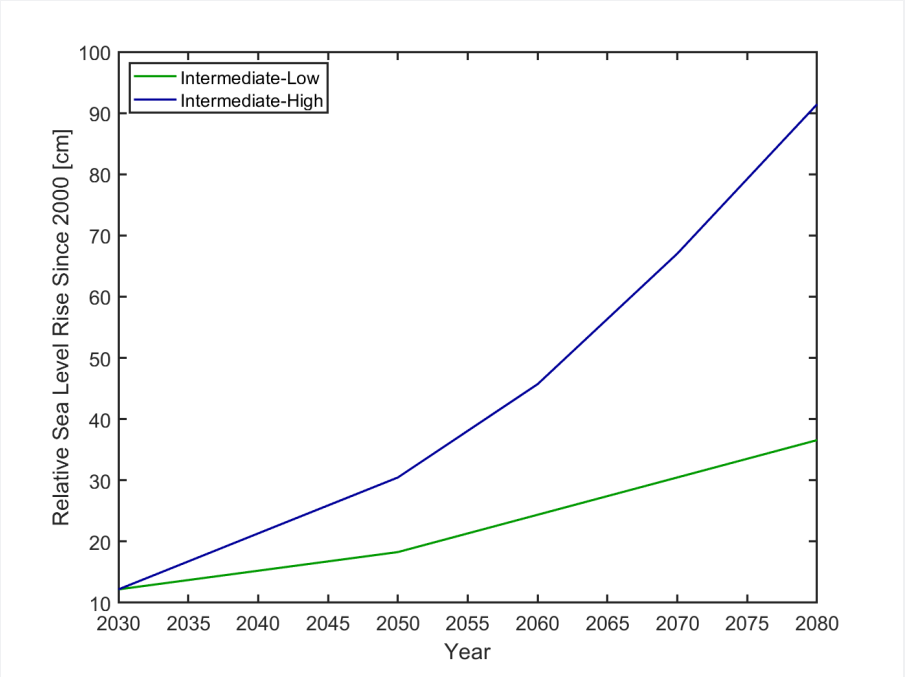
TABLE 6. *Sea Level Scenarios for San Francisco.*

Median values of Sea Level Scenarios, in feet, for each decade from 2020 to 2150, with a baseline of 2000. All median scenario values incorporate the local estimate of vertical land motion.

YEAR	LOW	INT-LOW	INTERMEDIATE	INT-HIGH	HIGH
2020	0.2	0.2	0.2	0.3	0.3
2030	0.3	0.4	0.4	0.4	0.4
2040	0.4	0.5	0.6	0.7	0.8
2050	0.5	0.6	0.8	1.0	1.3
2060	0.6	0.8	1.1	1.5	2.0
2070	0.7	1.0	1.4	2.2	2.9
2080	0.8	1.2	1.8	3.0	4.1
2090	0.9	1.4	2.4	3.8	5.3
2100	1.0	1.6	3.1	4.8	6.5
2110	1.0	1.8	3.8	5.6	7.8
2120	1.1	2.0	4.4	6.4	9.0
2130	1.2	2.2	4.9	7.0	9.9
2140	1.3	2.4	5.4	7.6	10.8
2150	1.3	2.6	6.0	8.1	11.7

Source: California Sea Level Guidance 2024 (OPC 2024)

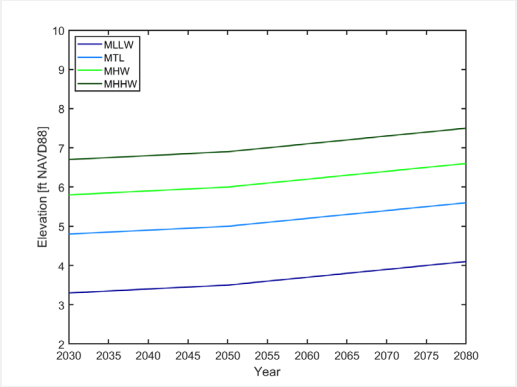
Tidal Datum Assumptions

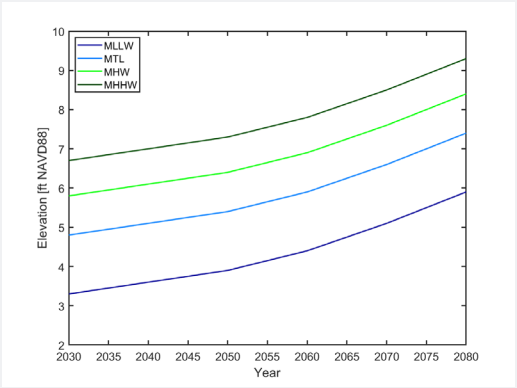


INT-LOW SLR

INT-HIGH SLR

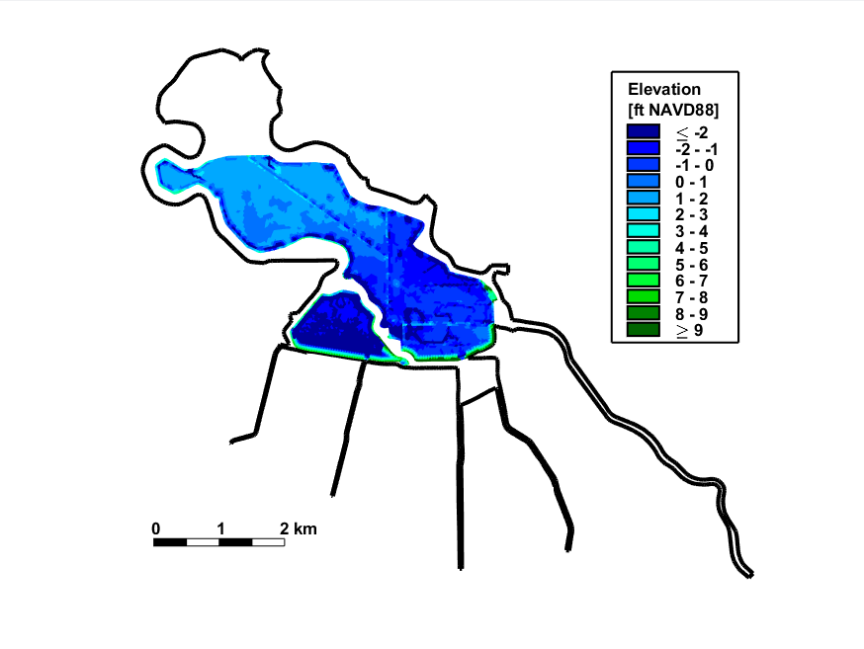
Tidal Datums



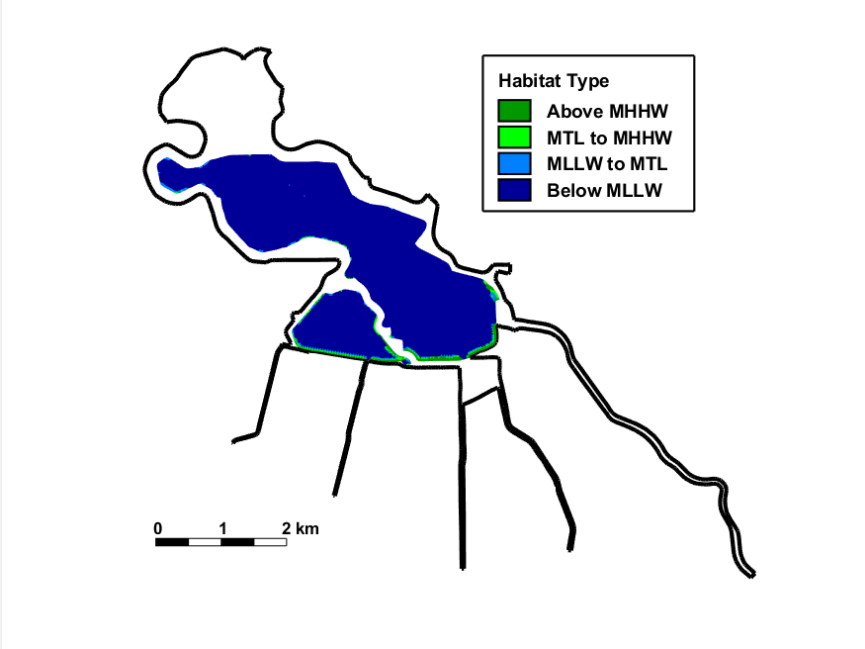


WARMER Initial Condition

Initial Pond elevations (2030)

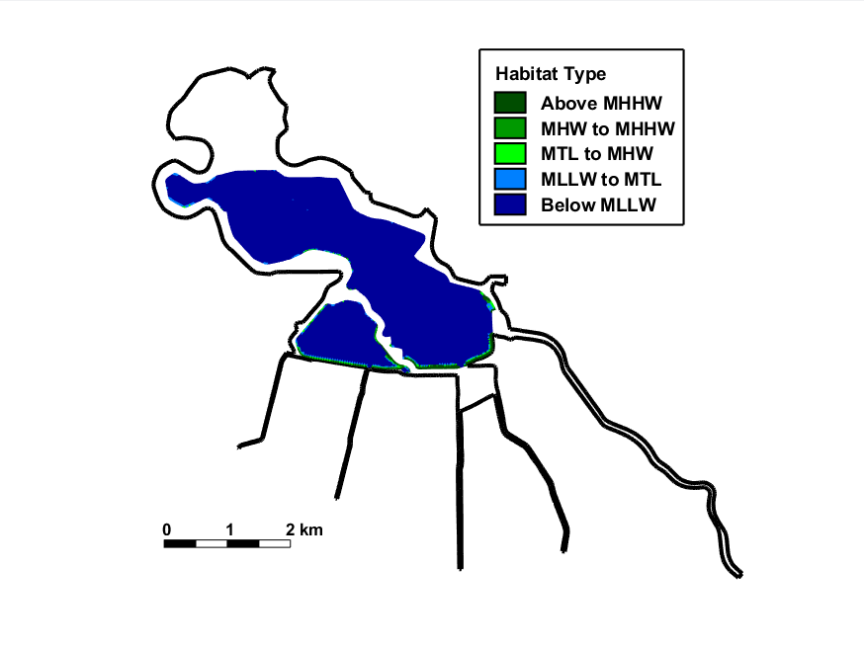


Habitat Type Based on Tidal Datums (2030)

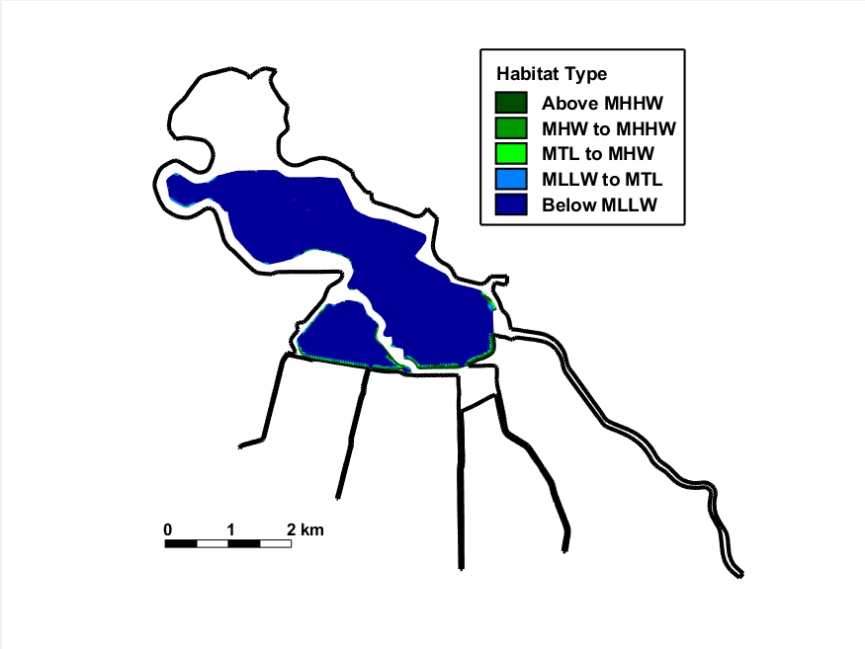


Habitat Predictions: 2030

WARMER: Bay Sediment Only



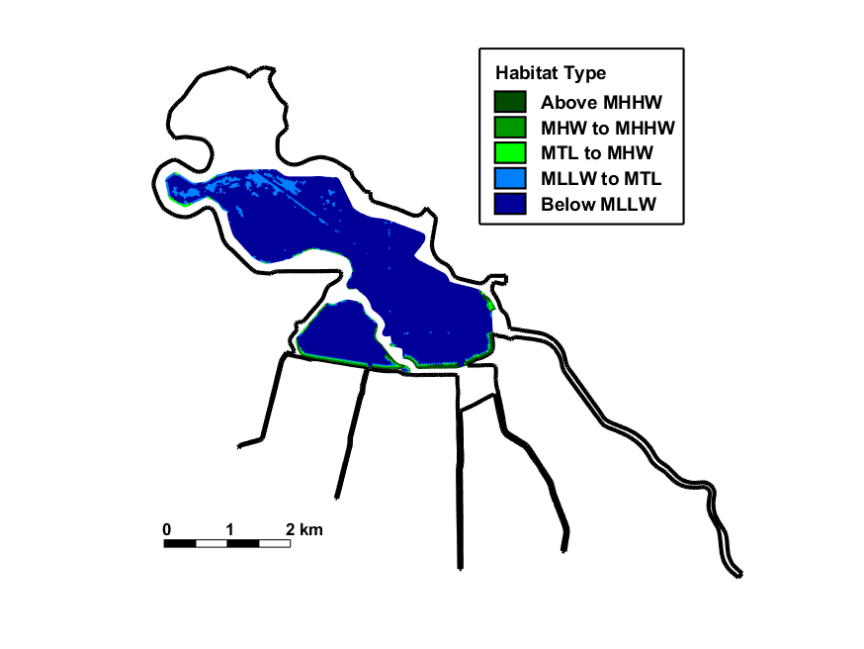
WARMER + Creek Sediment



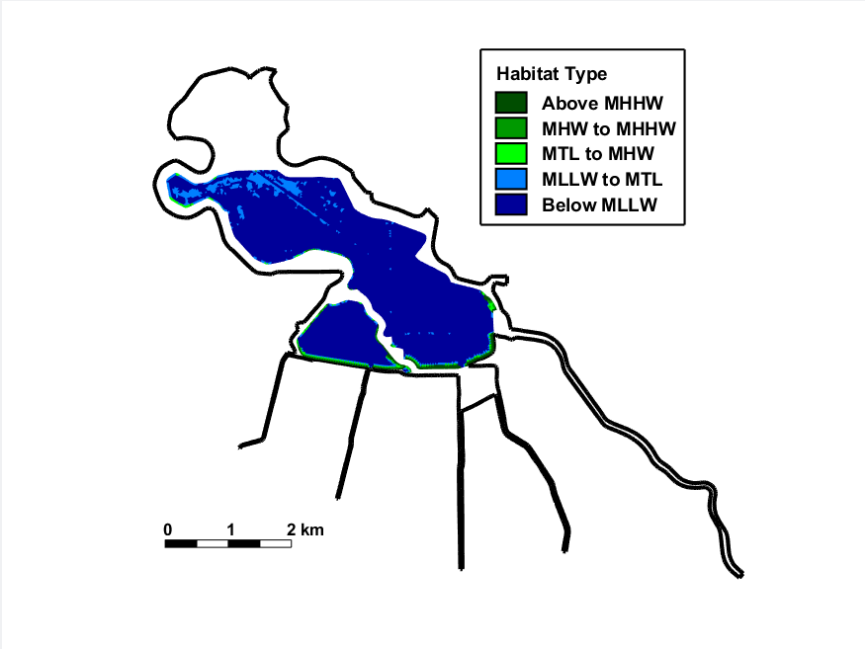
Intermediate-Low SLR

Habitat Predictions: 2040

WARMER: Bay Sediment Only



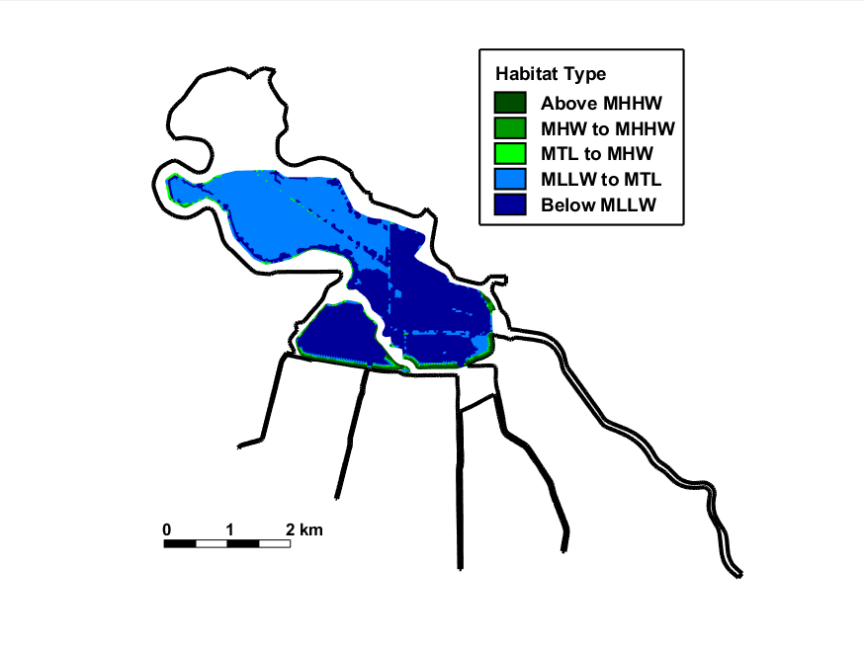
WARMER + Creek Sediment



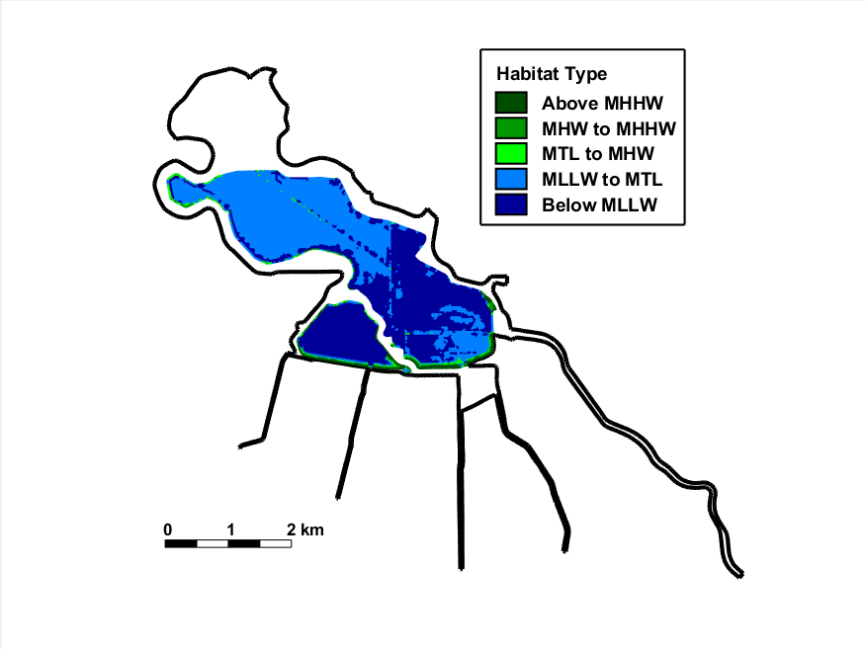
Intermediate-Low SLR

Habitat Predictions: 2050

WARMER: Bay Sediment Only



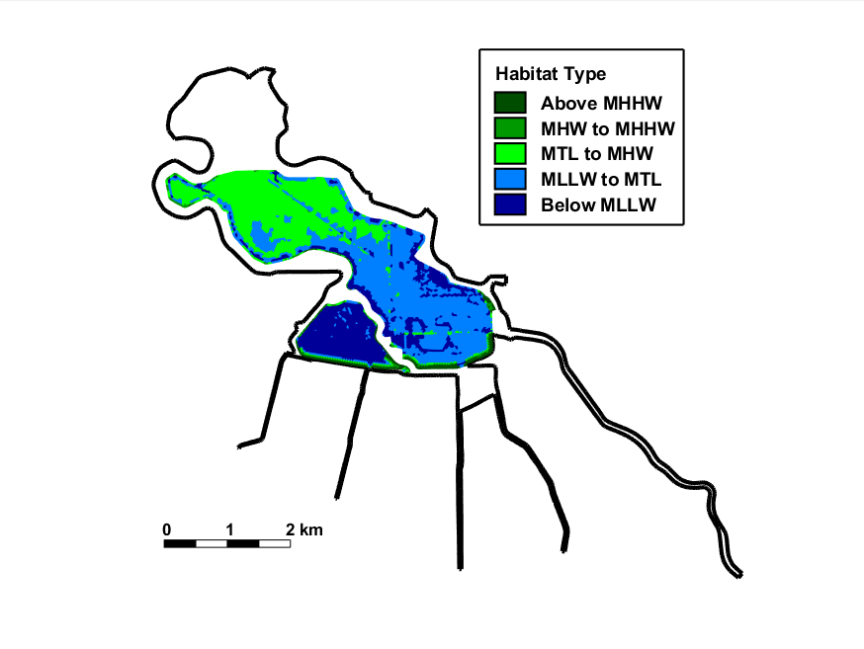
WARMER + Creek Sediment



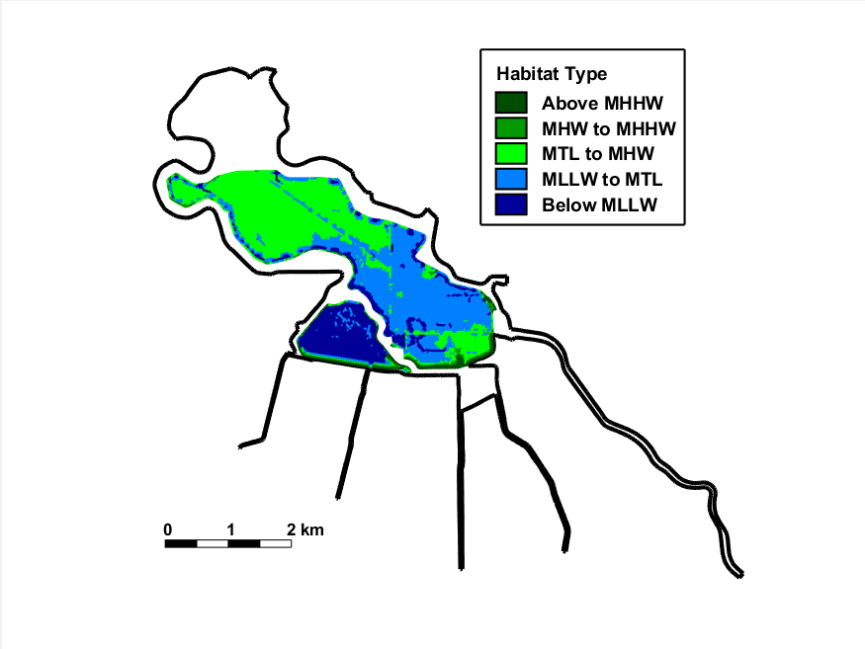
Intermediate-Low SLR

Habitat Predictions: 2060

WARMER: Bay Sediment Only



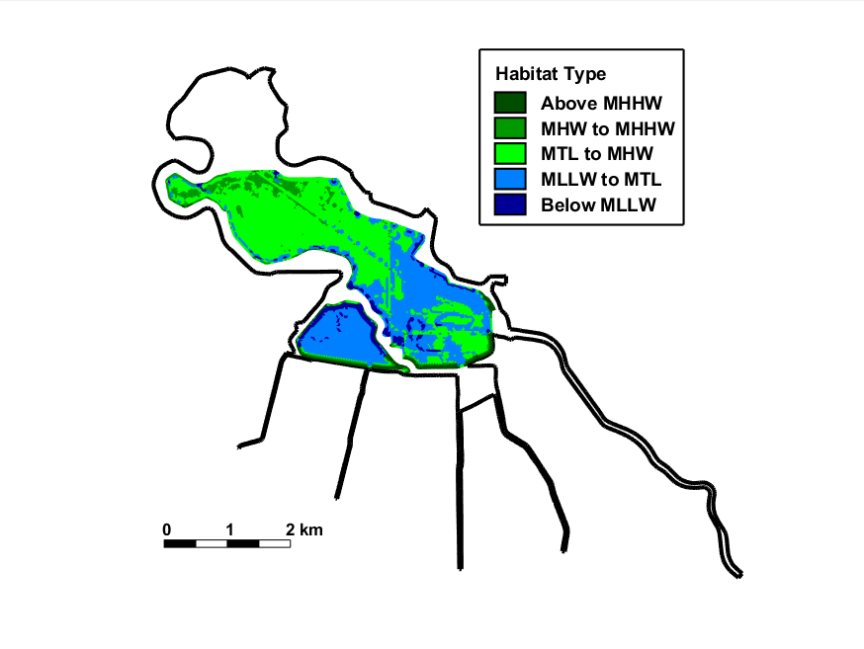
WARMER + Creek Sediment



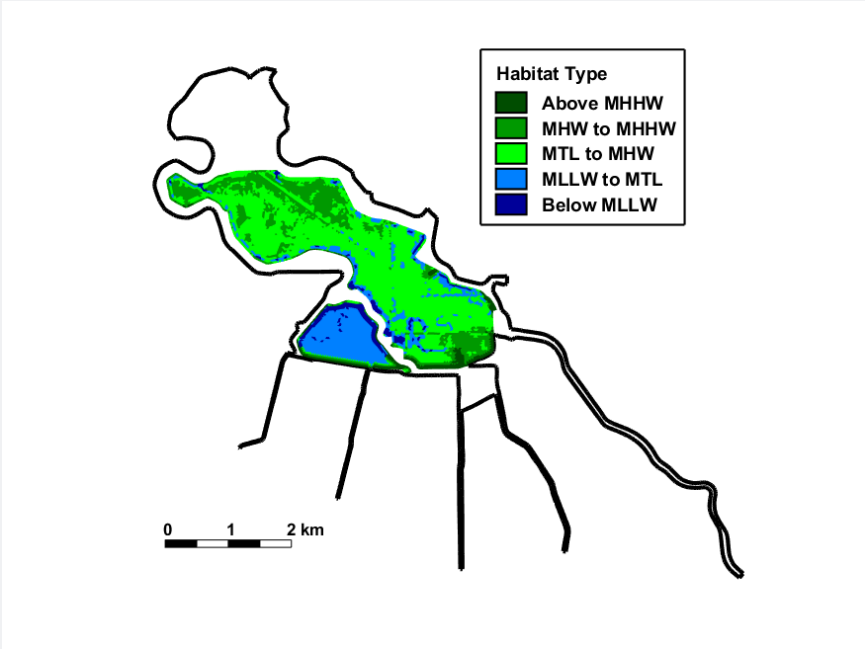
Intermediate-Low SLR

Habitat Predictions: 2070

WARMER: Bay Sediment Only



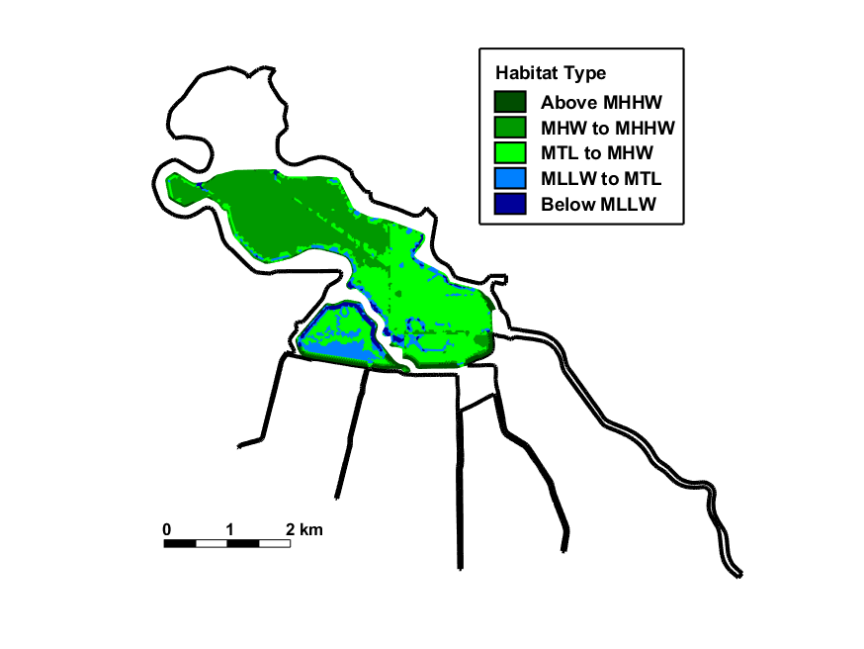
WARMER + Creek Sediment



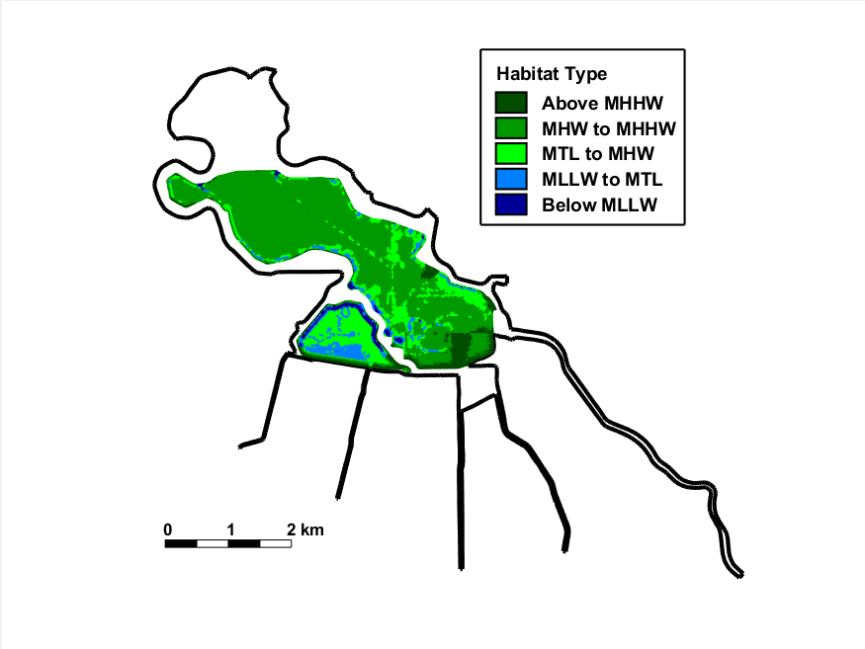
Intermediate-Low SLR

Habitat Predictions: 2080

WARMER: Bay Sediment Only



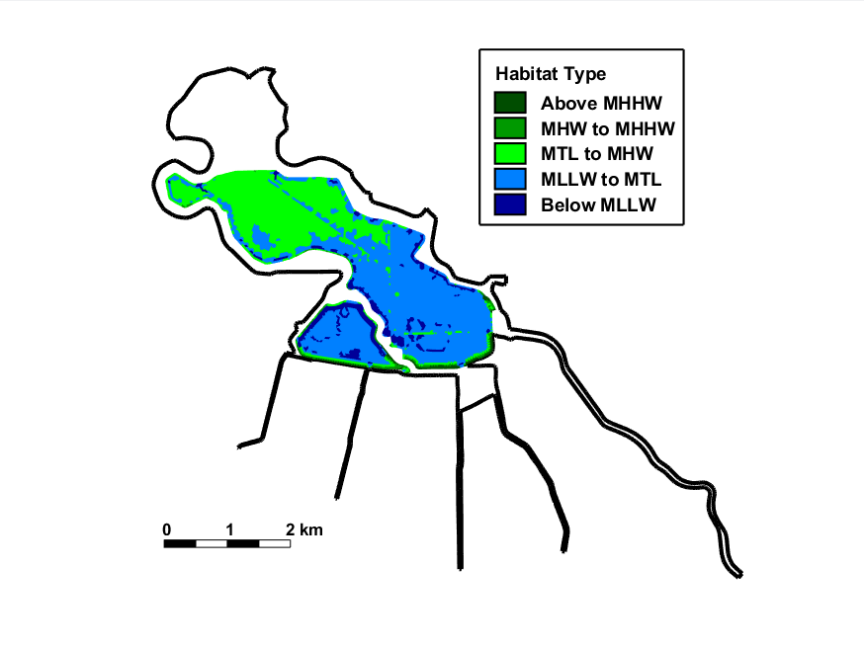
WARMER + Creek Sediment



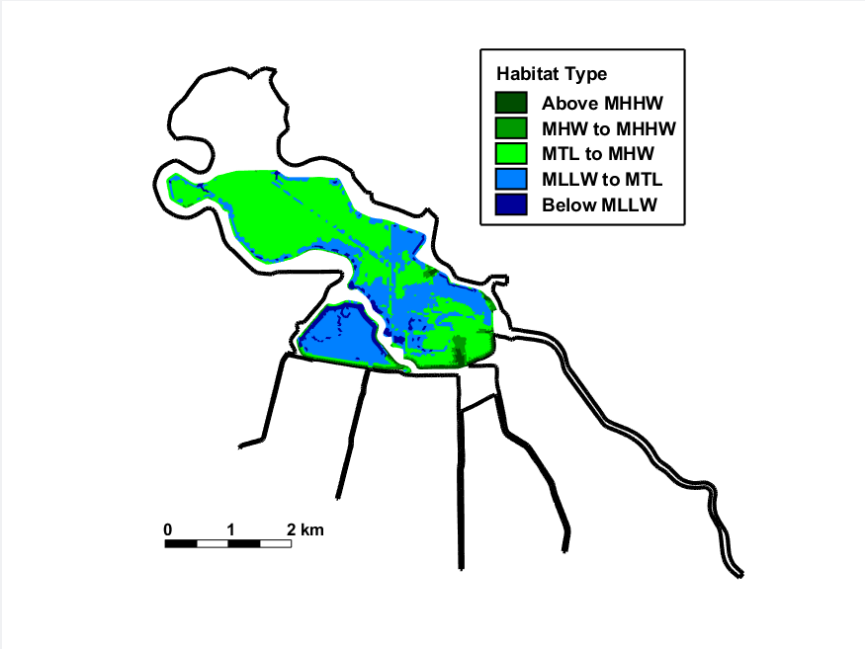
Intermediate-Low SLR

Habitat Predictions: 2080

WARMER: Bay Sediment Only



WARMER + Creek Sediment

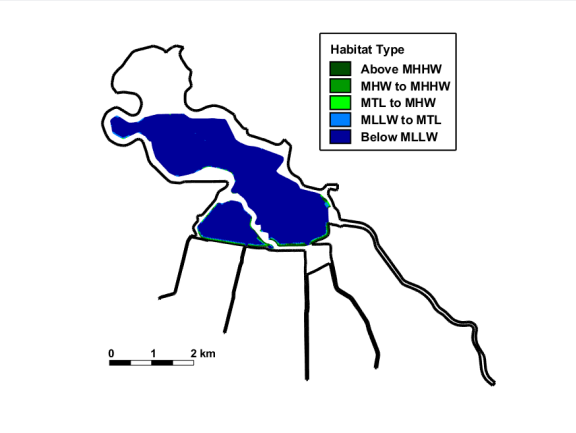


Intermediate-High SLR

Predicting long-term sediment accumulation and habitat evolution

Models can be used to predict long-term outcomes

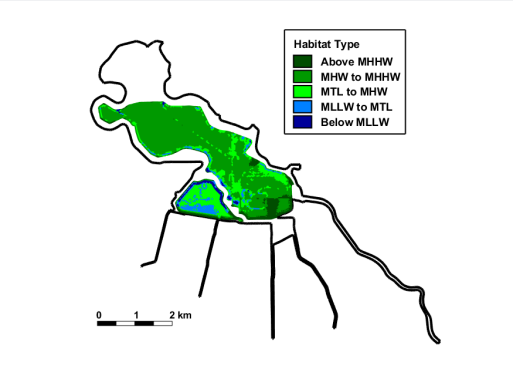
2030

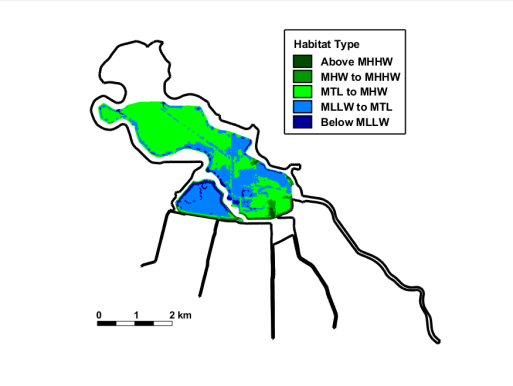


INT-LOW SLR

INT-HIGH SLR

2080





Closing Thoughts

The Role of Modeling in Project Planning and Design

- Modeling was used to analyze and refine alternatives, and was used to help select the recommended alternative.
- 3-D sediment transport modeling showed that while deposition in the A5/A7/A8 Pond group was dominated by Bay sediment, creek sediment was a large component of deposition in Pond A8.
- Long-term marsh accretion modeling showed that the creek-marsh connection accelerated the rate of marsh habitat development.
- Modeling for this study shows that reconnecting sediment supply from creeks to tidal wetlands contributes to ecosystem resilience.

Questions?

FlowWest